

DOCKET NO: 265125US2PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :  
TOSHIMITSU KOHARA, ET AL. : EXAMINER: BERMAN, J.  
SERIAL NO: 10/523,815 :  
FILED: FEBRUARY 4, 2005 : GROUP ART UNIT: 1795  
FOR: METHOD OF PRODUCING & :  
CRYSTAL STRUCTURE-BASED  
ALUMINA FILMS

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

COMMISSIONER FOR PATENTS  
ALEXANDRIA, VIRGINIA 22313  
SIR:

**I. REAL PARTY IN INTEREST**

The real party in interest is KABUSHIKI KAISHA KOBE SEIKO SHO, a Japanese corporation.

**II. RELATED APPEALS AND INTERFERENCES**

There are no related appeals or interferences.

**III. STATUS OF CLAIMS**

Claims 1-20 and 30-40 have been cancelled. Claims 21-29 stand finally rejected.

#### **IV. STATUS OF AMENDMENTS**

The amendment filed on April 30, 2009 has been entered upon the filing of this appeal (see Examiner Interview Summary dated May 22, 2009).

#### **V. SUMMARY OF CLAIMED SUBJECT MATTER**

The claimed invention is directed to a method for producing an  $\alpha$  crystal structure-based alumina film. Such  $\alpha$  crystal structure-based alumina films are useful where hardness and wear resistance are important, for example for coatings on cutting tools. It is well known that the crystalline structure of alumina varies depending on the formation temperature, and can be formed by reactive gas sputtering. Figure 1 represents a hysteresis curve showing the deposition modes as the discharge voltage and reactant gas flow rate is varied during sputtering. As is evident from the figure, the discharge conditions are generally classifiable into three modes: a metal mode, a poisoning mode and a transition mode between the metal and poisoning modes. The poisoning mode is able to achieve a high  $\alpha$  crystal alumina structure content but at a low film formation rate. The metal mode has a high film formation rate but produces films containing a higher metallic aluminum content. The transition mode provides a compromise with a lower metallic content and an adequate film formation rate, but is unstable.

The present invention is based upon Appellants' recognition that if the early stage of the film formation by sputtering is carried out under conditions best suited for the formation of  $\alpha$  crystal structure alumina, e.g., a poisoning mode, to thereby form an  $\alpha$  crystal structure alumina undercoat, one can subsequently change the film forming conditions to those suited for, e.g., greater productivity in a transition or metal mode, without significantly altering the

$\alpha$  crystal structure of the subsequently formed portions of the layer (page 13, lines 5-17).

That is, it has been found that if an undercoat of  $\alpha$  crystal structure alumina is first laid down, the conditions for a higher film forming rate can subsequently be adopted without a substantial deterioration of the  $\alpha$  crystal alumina structure in the layer. This is evidently the result of a synergy whereby the  $\alpha$  crystal alumina underlayer creates an  $\alpha$  crystal alumina structure nucleus upon which further  $\alpha$  crystal structure alumina is thereafter readily grown (paragraph bridging pages 13-14). An adequate film forming rate can therefore be achieved without a substantial loss in the quality of the produced  $\alpha$  crystal structure alumina layer.

More particularly, the invention of Claim 21 is a method of producing an  $\alpha$  crystal structure-based alumina film (p. 12, lines 20-23), comprising an initial first step of forming an undercoat of the alumina film having an  $\alpha$  crystal structure under conditions suited for formation of  $\alpha$  crystal structure alumina (p. 13, lines 5-17) by sputtering of an aluminum metal target in an oxidizing gas-containing atmosphere (sentence bridging pp. 12-13); and a subsequent second step of continuing to form the film on the undercoat by changing the film forming conditions (p. 14, line 1 to p. 15, line 8) whereby an  $\alpha$  crystal structure alumina continues to be formed on the undercoat (sentence bridging pp. 13-14).

In the invention of Claim 22, the film forming conditions in the second step are changed to higher rate film forming conditions (p. 14, lines 11-14).

In the invention of Claim 24, the film formation in the first step is carried out in a poisoning mode discharge condition and the discharge condition in said second step is changed to a transition mode or a metal mode (p. 14, lines 11-14).

## **VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

Claims 21, 23 and 26-27 stand finally rejected under 35 U.S.C. §103 as being obvious over the publication entitled “Surface and Coatings Technology” (Zywitzki), 1996, pp. 169-175. According to the final rejection (bottom paragraph of p. 3):

Zywitzki does not explicitly disclose the formation of the alumina structure in a two step process, but does disclose various temperature conditions in which a film may be formed and the resulting properties. ... One of ordinary skill would recognize that the experiments were either performed on different substrates ... or each layer was formed and tested subsequently on the same substrate, forming a stack of individual layers. The second scenario would read on the instant claim.

Claims 22, 25 and 28-29 stand finally rejected under 35 U.S.C. §103 as being obvious over Zywitzki in view of U.S. patent 5,789,071 (Sproul). According to the final rejection, it would have been obvious in view of the description at col. 12, lines 37-44 of Sproul to increase the deposition rate during film formation.

Claim 24 stands finally rejected under 35 U.S.C. §103 as being obvious over Zywitzki in view of U.S. patent 6,290,825 (Fu). According to the final rejection, it would have been obvious in view of Fu to have begun film formation in a poisoning mode, followed by a metal mode.

## **VII. ARGUMENT**

### **Rejection of Claims 21, 23 and 26-27 as being obvious over Zywitzki.**

Claim 21 recites two step film forming process. It is undisputed that “Zywitzki does not explicitly disclose the formation of the alumina structure in a two step process.” Zywitzki et al is concerned with the effect of substrate temperatures on the properties of sputtered alumina layers. It describes that the sputtered alumina layer is amorphous where the substrate temperature is less than 500°C, is metastable crystalline where the substrate

temperature is between 500°C and 1000°C, and is  $\alpha$  crystal structure only where the substrate temperature is greater than 1000°C. For example, p. 169 of Zywitski et al describes that the strongest influence on the alumina phase to be produced during CVD and PVD production is the substrate temperature, and that stable  $\alpha$  crystal phase layers require substrate temperatures above 1,000°C. Fig. 4 on p. 173 illustrates the relationship between substrate temperature and hardness. Moreover, the “Experimental Setup” described on page 170 indicates that the relationship shown in Fig. 4 was determined by applying the alumina layers on substrates having temperatures of 330, 480, 560, 690 and 760°C.

Although there is no dispute that “Zywitski does not explicitly disclose the [claimed] formation of the alumina structure in a two step process,” it is Appellant’s understanding of the Examiner’s position in the final rejection that it would have been obvious for the tests represented by the data points indicating the layer hardness in Fig. 4 of Zywitski et al to be performed using the same substrate at each temperature for reasons of “energy savings, expected fluctuations from feedback controls or necessity to form a desired gradient coating” (p. 4). In such a case, the layers corresponding to the data points would be formed one-over-the-other in a multi-step process having changed film forming conditions after the initial layer is formed.

However, it would make no sense for one skilled in the art to perform coating hardness testing to produce the hardness results shown in Fig. 4 by applying multiple coating layers one-over-the-other on the same substrate since this would produce meaningless results. In such a case the hardness of the second and subsequent coating layer being tested would depend on the harness of the layer(s) underneath. That is, the measured hardness of a given coating layer applied onto a previously applied layer would be affected by the hardness of the previously applied layer and would be different from the measured hardness of the given layer applied directly on the substrate. Therefore the test results of Fig. 4 would be

meaningless in the case of multiple layers applied on the same substrate unless the reader was provided with a way to account for the effect of the underlayer on the measured hardness.

Alternatively, it is Appellant's understanding from the Advisory Action of May 11, 2009 that it is also the Examiner's position that since Fig. 4 of Zywitski et al shows that an  $\alpha$  crystal phase alumina layer can be formed at different temperatures, i.e., different film forming conditions, one skilled in the art would have found it obvious to form such a layer in at least two steps performed under different conditions to achieve desired properties.

It is respectfully submitted, however, that the claimed two step process, with changed film forming conditions in the second step, would not have been obvious simply because it was known in the art that the possible conditions for forming an  $\alpha$  crystal phase alumina layer by sputtering are not limited to a single set of conditions. This is so for at least two reasons.

First, the teaching of Zywitski et al is simply that an  $\alpha$  crystal phase alumina layer can be formed by sputtering at one of different temperatures. This may render it obvious to choose the appropriate temperature for the desired layer characteristics in a single step sputtering process, but it would not have rendered it obvious to perform the sputtering process in two steps with changed film forming conditions in the second step. The purported motivation put forth in the Advisory Action to perform sputtering in two steps "under changing conditions," i.e., a motivation to achieve "the desired properties," does not require a second step with changed properties; it only requires the selection of the appropriate temperature for the desired layer characteristics in a single step. The conclusion of the Advisory Action that it would have been obvious, from a motivation to achieve "the desired properties," to perform the sputtering process in two steps with changed film forming conditions in the second step presumes that it was known in the art to form an  $\alpha$  crystal phase alumina layer by sputtering in two steps. No teaching of this is present in the cited prior art.

Second, the claimed invention provides unpredictable improved results as compared to a one step sputtering process. *KSR International Company v. Teleflex Incorporated*, 127 S. Ct. 1727 (2007). That is, the invention is based upon the recognition of a synergy whereby a high level of  $\alpha$  crystal alumina structure can be maintained, even under the changed conditions suitable for rapid deposition, once a nucleus of an  $\alpha$  crystal structure underlayer has first been laid down in a first step performed under conditions suited for formation of a high level of the  $\alpha$  crystal structure alumina. This would not have been predictable from the simple disclosure in Zywitski et al that the formation of  $\alpha$  crystal structure alumina is temperature dependent since there is no evidence that one skilled in the art would have expected that one could achieve both a high level of  $\alpha$  crystal structure and a rapid deposition rate by a second sputtering step with changed film forming conditions.

Accordingly, the subject matter of Claims 21, 23 and 26-27 would not have been obvious from Zywitski et al.

**Rejection of Claims 22, 25 and 28-29 as being obvious over Zywitski in view of Sproul.**

Claim 22 further recites that the film forming conditions in the second step are changed to higher rate film forming conditions. Fig. 15 of Sproul et al was cited to show “changes of operating conditions during film deposition resulting in an increasing deposition rate.”

Sproul et al is directed to a deposition coating method, wherein Fig. 15 is a graph showing a plurality of data points indicating a relationship between the substrate current density and deposition rate whereby the deposition rate increases with increased current density. According to the Advisory Action, since Fig. 15 of Sproul et al shows that the film forming rate changes with changes in substrate current density, it would have been obvious in

view of Sproul et al to perform the method of Zywitski et al using a second step providing higher rate film forming conditions “in order to obtain the desired effect.”

However, as with Fig. 4 of Zywitski et al, Fig. 15 of Sproul et al merely shows data points for the deposition rates in separate experiments *using separate substrates*; it does not teach a two step sputter deposition process with higher rate film forming conditions in the second step to form a film on an undercoat. Moreover, the mere fact that it was known that different deposition conditions when sputter forming an  $\alpha$  crystal phase alumina layer provide different deposition rates would not render it obvious to *change* the deposition conditions to higher rate film forming conditions during sputtering on a given substrate, particularly in view of the unpredictable improved results stemming from the invention. The claims therefore define over Zywitski et al in view of Sproul et al.

**Rejection of Claim 24 as being obvious over Zywitzki in view of Fu.**

Claim 24 further recites that the film formation in the first step is carried out in a poisoning mode discharge condition and the discharge condition of the second step is changed to a transition mode or a metal mode. According to the final rejection, Fu discloses “a method of initiating the deposition at a poisoning mode and then moving into metallic mode.”

Fu discloses the production of a titanium nitride (TiN) – not alumina -- layer by sputtering. According to Fu, the TiN film produced by a poisoning mode may sometimes be desirable because it has low stress (column 11, lines 43-45; column 12, lines 14-15). Therefore, if one wishes to produce the generally preferred metallic mode, it is desirable not to exceed the intermediate ramp up pressure line 200 in Figure 17, but that if the poison mode is preferred, one first reaches the higher pressure 206 followed by decreasing pressure on the ramp down intermediate pressure line 202 (column 12, lines 15-17).



However, this description would not suggest modifying the prior art according to any of the claims. As a threshold matter, it is submitted that Fu has no relevance to the present invention since it is directed to the reactive sputtering of TiN, and not alumina. Thus, the evident desirability of a poison mode in Fu has no relevance to the desirability of a poison mode for alumina since there is no evidence that an alumina layer produced in the poisoning mode would have characteristics which are advantageous in the manner described for the TiN layer produced in the poisoning mode of Fu (column 11, lines 43-45).

Beyond this, Fu does not disclose “a method of initiating the deposition at a poisoning mode and then moving into metallic mode.” Instead, the teaching of Fu is for the *opposite*: i.e., an initial metallic mode may be followed by the poison mode. That is, lines 5-12 of column 12 in Fu describe that for the metallic mode one should ramp up along line 200 and remain in the metallic mode. On the other hand, where the poisoning mode is preferred, one first goes to the higher pressure 206 along the metallic mode line 200, followed by ramping down in the poisoning mode line 202 (column 12, lines 13-16).

The Advisory Action noted that the background portion of Fu states that it was known that sputtering can also be used to form an alumina layer (col. 1, lines 30-35). **Nonetheless, Fig. 17 and the description beginning at line 35 of col. 11 deal exclusively with reactive sputtering using nitrogen gas to form a TiN layer.** The evident desirability of a poison mode in Fu when producing a TiN layer has no relevance to the desirability of a poison mode for alumina since there is no evidence that an alumina layer produced in the poisoning mode would have characteristics which are advantageous in the manner of the TiN layer produced in the poisoning mode of Fu.

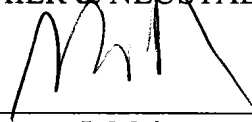
It is also Appellants’ understanding of the Advisory Action that it is considered that Fu would teach a method of initiating the deposition at a poisoning mode and then moving into metallic mode if one begins with the high pressure at point 206 of Fig. 17, followed by a

ramp down along line 202 (poisoning mode) and then a subsequent ramp up along the metallic mode line 200 back to point 206. However, since Fu does not disclose more than a single pressure cycle for the deposition of the TiN layer, the subsequent ramp up along the metallic mode line 200 is not taught therein. Accordingly, the claims also define over any combination of the prior art including Fu.

Appellants therefore request that the final rejection be REVERSED.

Respectfully submitted,

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**APPENDIX OF APPEALED CLAIMS**

Claim 21: A method of producing an  $\alpha$  crystal structure-based alumina film, comprising:

an initial first step of forming an undercoat of the alumina film having an  $\alpha$  crystal structure under conditions suited for formation of  $\alpha$  crystal structure alumina by sputtering of an aluminum metal target in an oxidizing gas-containing atmosphere; and

a subsequent second step of continuing to form the film on the undercoat by changing the film forming conditions whereby an  $\alpha$  crystal structure alumina continues to be formed on the undercoat.

Claim 22: A production method as set forth in Claim 21, wherein the film forming conditions in said second step are changed to higher rate film forming conditions.

Claim 23: A production method as set forth in Claim 21, wherein the film forming conditions in said second step are changed to lower temperature conditions.

Claim 24: A production method as set forth in Claim 22, wherein the film formation in said first step is carried out in a poisoning mode discharge condition and the discharge condition in said second step is changed to a transition mode or a metal mode.

Claim 25: A production method as set forth in Claim 22, wherein the film formation in the first step is carried out at a film formation rate not exceeding 1 nm/min and the second step is carried out at a film formation rate of not lower than 3 nm/min.

Claim 26: A production method as set forth in Claim 21, wherein the film formation in the first step of film formation is carried out at a substrate temperature not lower than 800°C and then a substrate temperature is lowered to 650-750°C for the second step.

Claim 27: A production method as set forth in Claim 21, wherein said second step is performed under conditions under which films with high hardness can be formed.

Claim 28: A production method as set forth in Claim 21, wherein said second step is performed by increasing the absolute value of a negative bias voltage.

Claim 29: A production method as set forth in Claim 21, wherein the first step is carried out while a negative bias voltage not higher than 100 V in absolute value is applied to the substrates and the second step is carried out while a negative bias voltage of 200 V or more is applied to the substrates.

**EVIDENCE APPENDIX**

None, other than in the specification.

**RELATED PROCEEDINGS APPENDIX**

None.